The LISTER HILL NATIONAL CENTER for BIOMEDICAL COMMUNICATIONS

REPORT to the CONGRESS

1974

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for
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BACKGROUND AND CONGRESSIONAL MANDATE

The Lister Hill National Center for Biomedical Communications (LHNCBC) had its start in 1965, when the Committee on Appropriations of the House of Representatives encouraged the National Library of Medicine (NLM) to develop a research capability. The Committee Report (HR No. 1464, 1966) on the Departments of Labor, and Health, Education, and Welfare, and Related Agencies Appropriations Bill for 1967 states:

> "The Committee finds a need to strengthen the National Library of Medicine's capabilities to disseminate existing information for the use of medical researchers, educators and practitioners through the medical library network . . . Technology now available can be applied to provide more effective access to information already organized and stored in the Library."

The Committee added $118,000 (and four positions) to the NLM budget and requested that they be used:

> ". . . for development and direction of the Library's applications of advanced technology to biomedical communications problems; for studying the application of library and related learning resources to the continuing education of health scientists and practitioners, and for planning and development of the Library's role as a center for biomedical communications. The record shows a need for such a role."

On August 3, 1968, President Lyndon B. Johnson signed Public Law 90-456 (Senate Joint Resolution #193) which authorized the Center. Secretary of Health, Education, and Welfare, Wilbur J. Cohen, announced the formal establishment of the Lister Hill National Center for Biomedical Communications on September 15, 1968, saying: "This Center honors Senator Lister Hill of Alabama for his distinguished contributions to improved health for the American people. It will serve as the delegated agent for the Department in the development and coordination of networks and information systems to improve health education, medical research, and the delivery of health services."

The Center received its formal "Statement of Organization and Functions and Delegations of Authority" on November 8, 1968. The document (F.R. Doc. 68-13778, File, Nov. 14, 1968) read, in part:

> "Lister Hill National Center for Biomedical Communications (2328) (1) Designs, develops, implements and manages a Biomedical Communications Network; (2) assists the biomedical community in identifying and developing products and services for dissemination through the network; (3) develops networks and information systems to improve health education, medical research and the delivery of health services; (4) applies technology to the improvement of biomedical communications; (5) represents DHEW in Federal activities related to biomedical communications activities; and (6) serves as the focal point in the Department for development and coordination of biomedical communications, systems and network projects."

THE LISTER HILL CENTER TODAY

The Lister Hill National Center for Biomedical Communications has a staff of sixteen, and an annual budget of approximately $2,000,000. Its offices and laboratory are located in the National Library of Medicine. Plans are underway for the construction of a new building which the Center will share with other Library activities. This structure, to be adjacent to the present Library building, will feature a ten-

story tower and three underground levels and will contain approximately 200,000 gross square feet of space. Final working drawings are to be completed by December 1974.

The Lister Hill Center has isolated four problem areas where communications technology can make substantial contributions towards solutions. These four areas are:

a. The use of communication technology to promote better utilization of health care resources by reducing the deleterious effects of maldistribution of health professionals and health services and by facilitating the provision of consumer education concerning health services;

b. The use of communication technology to improve the quality of health care records and by improving access to data sources which are necessary for the evaluation of the quality of care;

c. The use of communication technology in the preparation/education of health professionals by facilitating a more equitable distribution of medical education resources, by helping students become familiar with technology and its potential, by improving the quality of educational resources and by providing resources which make alternative presentation modes possible, so as to adapt the educational processes to be more responsive to the individual student needs;

d. The use of communication technology to sustain and update the competence of health professionals by helping health professionals become familiar with technology and its uses, reducing the deleterious effects of maldistribution of resources for continuing education, and improving the quality of resources for continuing education.

CURRENT PROJECTS

The Lister Hill Center initiated and manages a number of projects to meet these goals. Because of a lack of in-house technical facilities, the principal implementation method is the research contract. The LHNCBC uses its funds to develop, test, and evaluate prototype networks rather than operate such networks. At such times as they show promise of becoming self-sustaining, or have provided all necessary data, the LHNCBC withdraws support to free funds for new projects. The five major program areas with which the Lister Hill Center is currently involved are:

a. Satellite Communication Medical Consultative Network;

b. ATS–F Satellite Advanced Health Care and Education Experiments;

c. Cable Television for Consumer Health Education;

d. New Hampshire/Vermont Medical Interactive Television Network;

e. Computer Assisted Instruction.

Satellite Communication Medical Consultative Network

Satellite communication was introduced to remote areas of Alaska in the late summer of 1971 through an experimental medical network financed by the National Library of Medicine's Lister Hill National Center for Biomedical Communications.[1] Ground stations costing about $3,000 each were installed by the University of Alaska's Geophysical Institute, which manages the network and maintains the equipment. The National Aeronautics and Space Administration's (NASA's) Application Technology Satellite (ATS-1) is used like a tall (22,000 mile high) tower providing line of sight communication to and from each of 26 ground stations located throughout the state, avoiding most of the interference which plagues conventional high-frequency radio communication in Alaska. The network has been used to demonstrate and document the potentials of improved voice communication between and among widely dispersed native community health aides, doctors and nurses in Central Alaska.

The major experiment involves daily two-way communication between community health aides in geographically isolated communities and a Public Health Service doctor located in the Service Unit Hospital. Health aides, who after twelve weeks of training provide all of the primary health care in their communities, are now able to consult daily with a doctor concerning diagnosis and treatment of many of their cases where formerly radio contact was uncertain and could result in periods of "blackout"—no communications—for periods of up to a week.

Each of the participating health aides has a "satellite radio" in her home connected by cable to the nearby antenna. Every day a doctor at Tanana calls each health aide in turn on the single "party-line" satellite radio channel. Health aides may ask the doctor for specific instructions after describing signs and symptoms. The medical facilities in the villages are still very limited, so that serious cases may be evacuated. The satellite radio can then be used to arrange for a plane to transfer such patients to the nearest medical facility.

Other uses of the satellite radio that have been demonstrated include: the capability for hospitalized patients to talk to their families in the villages via satellite; the use of the satellite for medical education of remotely located students, health aides and nurses; on-line computer access to medical data bases via satellite; doctor-to-doctor consultation; ECG transmission; and facsimile transmission.

An interdisciplinary team from Stanford University is presently evaluating the Alaska biomedical communication project under contract with the Lister Hill Center.[2] Preliminary findings of this evaluation show an increase of nearly 400% in the number of patients now treated with a doctor's advice as compared with the period prior to the availability of reliable telecommunication. Based on a case-by-case analysis of individual doctor-health aide consultations, Public Health Service doctors believe that more than one-third of the consultations had a definite effect relating to the future well-being of, or prevention of disability in the patient. In addition to the documentation of changes in Alaskan health care delivery, cost projections for alternative operational networks involving both satellite and terrestrial links are being provided to the Indian Health Service (IHS).

1. Albert Feiner: "An Experimental Satellite Medical Network for Scarcity Areas." Presented at 8th Annual AIAA Meeting, Washington, D.C., Oct. 25, 1971.
2. Heather E. Hudson and E.B. Parker: "Medical Communication in Alaska by Satellite." *New Eng. J. Med. 289,* 1351–1356. 1973

ATS–F Satellite Advanced Health Care and Education Experiments

The NASA Application Technology Satellite Series F (ATS–F) to be launched in 1974 is the sixth of a series of experimental satellites designed to explore communications, navigation and scientific phenomena in space. The satellite will be in operational orbit over 94° west longitude. This satellite is sufficiently powerful to provide quality television with simple, relatively inexpensive ground terminals. The Lister Hill National Center for Biomedical Communications has been designated as the DHEW focal point for coordinating health experiments over this satellite. The Center is involved in the following experiments:

Alaska Health Experiment: This experiment will implement a coordinated telemedicine and health information system at four health facilities in Alaska. Audio/data/video communication links will be provided between primary health care providers (community health aide and nurse) with physicians at a Service Unit Hospital and medical specialists at the medical center in Anchorage. Television equipment and biomedical telemetry instruments will permit medical diagnosis and consultation, and the capability of general practice physicians at a Service Unit Hospital will be augmented by consultation with specialists at the Alaska Native Medical Center. Video will be provided for continuing education of isolated health professionals as well as direct health education for the Native population.

It is expected that the use of these communication technologies will eliminate unnecessary patient transfer from the village while increasing more appropriate referrals to medical specialists; provide an increased level of preventive health maintenance procedures; facilitate earlier disease detection and medical intervention; provide improved continuity of care through improved follow-up procedures; provide the Native population with improved understanding of health and the health care system; increase availability and use of medical specialists at the village level; reduce travel by medical specialists to remote villages; and assure provider compliance with disease-specific standards of health care.

The ATS–F satellite will be used for the video links, while audio and data links will be via the ATS–1 spacecraft.

Regionalized Medical School (WAMI): The experiment will apply interactive audio, data and television to the solution of problems encountered in providing basic science education to students remotely located from a major medical school. Most course material will originate at the University of Washington in

Seattle and flow to students located at Fairbanks in Alaska. However, some programs will originate at the outlying sites and be evaluated by the staff at the University. Video and audio will also be used to provide administrative conferencing between officials at all locations, for counseling students, for interaction between students to relieve the feelings of receiving an inferior education off-campus, and for computer evaluation of students' progress in specified areas.

Undergraduate clinical and continuing education will be carried out between the University of Washington faculty and third and fourth year medical students in clerkship under practicing physicians in Omak, Washington. Both local faculty at the University and peripheral faculty at Omak will review and critique the students' patient presentations. The physicians at Omak will on occasion present patients to specialists at Seattle for consultation, thus enhancing their ability to handle difficult patient problems locally.

Satellite communications has great potential impact on the problems of maldistribution of health manpower. The location physicians choose to practice medicine shows a high degree of correlation with the location of their final graduate training. Telecommunication linkages between major medical centers and training centers in shortage areas may obviate the obstacles to establishing residency training centers in areas of physician shortages. The improved communications can also provide the necessary continuing education for physicians and other health professionals in remote areas in order to improve the quality of care and can provide an incentive to individuals to practice in such areas. A satellite could also provide the necessary linkage between established medical schools with existing universities in states having no medical schools. The necessary linkages between established academic medical centers in other states with newly developed clinical programs can also be accomplished via satellite. This can assist in providing the clinical training for part of the medical school.

Cable Television for Consumer Health Education

The Lister Hill National Center for Biomedical Communications is working with the Department of Community Medicine, Mount Sinai School of Medicine, New York City, to explore the application of communications technology to the dissemination of health information to an inner city geriatric population. The undertaking is unique, and the researchers will have no precedents to guide them.

The site of the proposed project is the Gaylord White House, a 248-apartment high-rise public housing building in East Harlem. The median age of the 339 tenants is 69 years.

The field of geriatrics was chosen not only because the health needs of this population are greater than any other age group—the elderly suffer more illnesses for longer periods of time—but also because the elderly account for a disproportionate amount of total health expenditures. Although people over 65 represent only 9.9 percent of the population, they account for 27.4 percent of the Nation's total health bill.

There is a real need for health care providers to learn how to communicate with the elderly. Operating on the basis that television is probably the most important of the media in the lives of the elderly, a cable television (CATV) system with interactive capabilities is being used to establish bidirectional communication. Television can be creatively used to reduce the social isolation suffered by many of the elderly and increase their life satisfaction. By disseminating health information via television and coordinating this with health care services, the hypothesis is that the state of health of the Gaylord White residents will be materially improved. Plans are being implemented to accomplish:

a. The installation of cable television (eventually with two-way communication capability) in each of the 248 apartments;
b. Activating a presently unused television channel for the exclusive use of the Gaylord White residents and the medical personnel of the Mount Sinai School of Medicine;
c. The production of health and nonhealth related programing for the channel with maximum involvement of Gaylord White residents.

As many tenants as possible are being involved in the production of programs that not only inform residents, but also elicit the desired behavioral responses, e.g., paying more attention to their own health problems, treatments, and actively dealing with preventive medicine for their own well-being. To develop these programs, residents have been trained in the use of portable camera and videotape equipment.

The purpose of this is two-fold. It will provide an important activity around which residents can develop a sense of community, thus offering the potentially active members a worthwhile and useful outlet for their energy. Tenant-produced programming will also stimulate interest in the Gaylord White CATV channel—residents will want to see themselves and friends on television. In addition, it offers the nonambulatory members vicarious participation in community activities.

At a later date, interactive terminals will be introduced to enable each tenant to respond to medical questions posed over the channel, solicit information, and make clinic appointments. An investigation is underway to determine the desirability and feasibility of using sensory devices to monitor and transmit patient medical data to the Mount Sinai Medical Center (for example, to the Emergency Room). The program will provide training for physicians in the application of telecommunications to a geriatric population.

Mount Sinai medical personnel will determine the information to be communicated. A production staff will translate this information into a language and form easily understood by Gaylord White residents. The programs, having been reviewed for accuracy, will be pretested with a small peer group and eventually cablecast to the entire Gaylord White population. A prime factor in the evaluation of programs will be the extent to which they elicit the desired response from the residents. Other anticipated evaluation procedures include:

a. The monitoring of resident viewing of the Gaylord White channel by floor captains and ultimately through the interactive channel;

b. Periodic sampling of the Gaylord White population, looking specifically for altered social activity, health activity (taking medications, nutrition, etc.), and life satisfaction levels;

c. Pre- and post-surveys of residents' health status and utilization of health care facilities;

d. Comparisons of medical expenditures over time, between Gaylord White residents and a control group with similar demographic characteristics.

Special attention will be paid to factors in health maintenance that are considered to be of importance to potential funders of health services, especially third party payers.

New Hampshire/Vermont Medical Interactive Television Network

Two-way interactive television provides one possible answer to the problems of continuing medical education faced by those who practice medicine in rural areas. Television can bring the medical school classroom to the small community hospital and, simultaneously, bring the busy community practitioner to the university classroom.

Supported by the Lister Hill National Center for Biomedical Communications, the New Hampshire/Vermont Medical Interactive Television Network initially consisted of a single link, over leased microwave facilities, connecting Dartmouth Medical School and Mary Hitchcock Memorial Hospital in Hanover, New Hampshire with Claremont General Hospital, 30 road-miles away. In the spring of 1972, construction began on a mountaintop microwave network, extending 150 miles to the northwest, linking Dartmouth with the University of Vermont College of Medicine and hospital in Burlington, Vermont. Central Vermont Hospital in Berlin was added to the network, while Claremont General Hospital was connected over the network microwave links, replacing the leased facilities. Construction and testing of this fixed network was completed in November 1972. Three additional stations served by a van-mounted mobile unit were Rockingham Memorial Hospital, Claremont Vocational Technical College and Windsor State Prison. They were connected to the network in November 1973. All three are within a 20-mile line-of-sight radius from Mt. Ascutney; all three have permanent antennas focused on the Ascutney tower. The van carries microwave transmitting and receiving equipment, and television cameras and monitors. On arrival at a site, the van is connected to local power and the antenna, the cameras and monitors wheeled inside, and the local site becomes part of the network.

The network has become a working tool for the medical and allied health personnel of these seven locations. During January of 1974, for example, the stations were on the air for a total of 278 hours, with individual users totaling 2078 viewer hours.

A management consulting firm was retained during 1973 to evaluate the impact, cost-effectiveness and potential for self-sufficiency of the network. Their report[1] showed that interactive television is an effective medium for the provision of educational and other services

in a rural medical setting:

a. For formal educational purposes the television is as effective as comparable classroom instruction;
b. There is a highly fragmented rural medical audience for current network programming;
c. The network may be of high value in promoting "best medical practice" by affirming practitioner judgments on case management and by encouraging the adoption of new practices already known to the rural medical community.

Different types of users get different benefits from the network. The *medical centers* derive experience as participants, use the network as a vehicle for service delivery and for faculty sharing. The *local community hospitals* derive status and needed information as participants in the network. They also feel that they gain the good will of the medical centers and have easy access to continuing education for their staffs. *General practitioners* find that the network offers them a low key, job relevant "break," and opportunity to test their ideas with colleagues at other institutions, and broadens their general knowledge. *Specialists,* on the other hand, welcome the network as an opportunity to maintain contact with physicians at other institutions. *Nurses,* who have had more formal courses offered over the network find that the network offers them both knowledge and certification, as well as a larger collegium, especially those in specialized units, such as Coronary Care.

The first period of operation and construction of this network, from July of 1970 through the fall of 1973, was devoted to exploring the uses and benefits of interactive television in a remote, rural area. The next two years will be devoted to testing the hypothesis that these uses and services can demonstrate cost benefits, to the point where users will assume a substantial portion of the costs of providing these communication links. An external management consultant has been retained to facilitate the transition from a purely research status to a financially independent one.

1. Molly K. Hageboeck and Leon J. Rosenberg: "Interactive Television: A Study of Its Effectiveness as a Medical Education Resource in the Rural Northeast." Practical Concepts, Inc. Washington, D.C. Nov. 1973. Available from National Technical Information Service, Springfield, Va. 22121, as PB 225172/6AS for $10.25 in hard copy or $1.75 in microfiche.

Computer Assisted Instruction

Since July 1972, the Lister Hill National Center for Biomedical Communications has been coordinating an experiment to foster the interinstitutional sharing of Computer Assisted Instruction (CAI) resources among medical schools, hospitals and other health related organizations. Three centers of biomedical CAI expertise were put on-line via a nationwide commercial time-sharing communications network. The three centers are Massachusetts General Hospital, Ohio State University College of Medicine and, until February of 1974, the University of Illinois at the Medical Center, Chicago. In May 1974, some, but not all, of the UIMC programs were being transferred to the Ohio State University computer so that they will continue to be available. The communications network is that of TYMSHARE, Inc. A complete history and description of the experiment are available in the literature.[1 2 3]

Over 80 institutions (primarily medical schools) have used the network for a variety of purposes. These include: introducing CAI on campuses; integrating available materials into the curriculum; using the network as a supplement to other forms of training; using the material as a remedial tool; stimulating local CAI activities; and encouraging broader faculty use of the variety of educational resources available. User institutions have been encouraged to prepare "educational material use and evaluation plans" and to submit evaluative reports, which are shared with the others. About 70 percent of the CAI network's current use is by medical students. The remainder of the time is used primarily by physicians, nurses and allied health personnel. Total usages have ranged as high as 2800 hours a month. An hour averages out to include 2.5 teaching sessions. Since there is a tendency for several students to group around the terminals and to interact as vigorously with each other as with the programs, it is probably conservative to estimate that the network has provided over 15,000 interactive teaching sessions per month.

Until February 1974, the Lister Hill Center absorbed most of the costs of the network. Users were required to provide suitable terminals, pay telephone charges to the nearest network con-

nection point, and assume the cost of the necessary faculty time for administering the program. Starting February 1, 1974, users were required to pay $2.50 per connect hour; after July 1, 1974, the charges rise to $5.00 per connect hour. These charges defray a portion of the total communications costs and do not reflect the computer and administrative costs paid to the several CAI centers. The remaining costs, about $12 per hour, will be borne by the Lister Hill Center for the duration of this phase of the experiment.

The network has demonstrated that schools are interested in sharing CAI materials for a variety of purposes; however, the present technical implementation of the network is too costly for the long run. Therefore, the Lister Hill Center is exploring alternative distribution methods, some of which may well involve an initial capital expenditure on the part of the using institutions, but which will result in substantially reduced operating costs. We are looking at computer language translation to permit wider distribution of materials, language standardization and the use of mini-computers at local nodes or even at the campus end of the network. The goal is to encourage the exchange of educational materials prepared on other campuses while, at the same time, encouraging local institutions to maintain greater control in local modification of materials, encouraging local authoring, and keeping records of individual student performance out of central national computers. The Lister Hill Center will also maintain an active interest in the broader problems of resource sharing including: evaluation methodologies, content development issues such as copyright and author incentives, and helping faculty members learn how to use these new materials effectively.

1. Harold Wooster: "The Lister Hill Experimental CAI Network—A Progress Report." *The Physiologist, 16,* 626—630, 1973.
2. Harold Wooster and Jinnet F. Lewis: "Distribution of Computer-Assisted Instructional Materials in Biomedicine through the Lister Hill Center Experimental Network." *Computers in Biology and Medicine,* 3, 319-323, 1973.
3. Jinnet F. Lewis and Harold Wooster: "Utilization of the Lister Hill Center Computer Assisted Instruction (CAI) Experimental Network." *Computer Medicine,* Vol. 3, No. 9, Unpaged special report. Sept. 1973.

THE LISTER HILL CENTER—YESTERDAY, TODAY, AND TOMORROW

The Lister Hill National Center for Biomedical Communications was established with a very broad charter which gave it, *inter alia,* responsibilities for developing networks and information systems to improve health education, medical research, and the delivery of health services. The Center does not have sufficient funds or technical facilities to impact equally on all of these areas. The basic management decisions, since the beginning of the Center, have been the choice of areas in which to use our relatively limited funds for maximum impact and benefit to the Nation's health education and practice. Both the areas chosen, and the methods of approach to these areas have changed as the Center has matured. The Center's years of existence to date may be divided into two periods:

Yesterday—The Planning Phase—1968–1971

As a new organization, with a very broad potential field of operation, the Center devoted much of its first three years to planning. Extensive staff activities were supplemented by contracts with "think tanks." The first of these was with Stanford Research Institute, followed by contracts with RAND, EDUCOM, and the Massachusetts Institute of Technology. The first planning contracts were general, helping to produce the first Five Year Plan of the Center. Later contracts had more specific end products. One, with Jansky and Bailey, led to the New Hampshire/Vermont Medical Television Network. Another, with Systems Development Corporation, built AIM-TWX, eventually to become MEDLINE. Others, with Stanford University, the University of Washington, and the Geophysical Institute of the University of Alaska, were the progenitors of the Alaskan Satellite Communications Medical Consultation Network. The emphasis during this first period, however, was more on careful long-range planning for future networks than on building working systems.

Today—The Operating Phase—1971–1974

This phase of the Lister Hill National Center for Biomedical Communications, produced a new, operational definition of biomedical communications—"Communications of biomedical interest taking place over a formal, electronic message transmission network." The medium was chosen to meet the needs of the message; networks developed, used, or operated by the Center have included microwave television, cable television, a national wire-line network, satellite voice radio and, most recently, satellite-to-ground television. The emphasis on all these networks, after carefully establishing the need for their services, has been—"Build, test, experiment, and evaluate."

Since its beginning, the Lister Hill Center has been a research and development organization, operating on a relatively fixed budget. Operating systems have a tendency to tie up more and more of this venture income, making it unavailable for future innovation. A new imperative has now been added, "Get the user or beneficiary to share the cost." Nonimpecunious users may be expected to share the costs directly, as is being planned for the New Hampshire/Vermont Medical Television Network or the Computer Assisted Instruction Network; the intervention of third-party payers may be needed for less affluent users. Whatever the mechanism, plans were well underway by the end of FY 74 to phase out, or transfer to other sources of support, most of the current Lister Hill projects. Research and development funds made available, from FY 75 onwards, will thus be freed for new directions and emphases.

Tomorrow—1975 Onwards

The Lister Hill National Center for Biomedical Communications is undergoing a major reorganization to prepare it for an expanded role in the coming decades. An external consultant has recommended that LHNCBC acquire staff competent in the following areas:

Technologies
- Community TV systems
- Computer assisted instruction systems
- Communications engineering
- Logic technology
- Storage technology
- Communications
- System organization
- Media and multimedia
- Display design and technology
- Terminals, interactive inputs and outputs
- Interactive graphics; computer-generated displays

Functions and/or Disciplines (Software emphasis)
- Network design
- Systems engineering
- Educational/learning theories; educational psychology
- Economic analyses (cost/benefit issues)
- Social, behavioral specialists
- Long range systems planning

Multidisciplinary Capabilities
- Experiment planning
- Organizational theorists
- Training, learning theory
- Medicine/economics/medical administration
- Legal, regulatory, privacy, security, ethical issues and technologies involved

Multiskilled MD Level Specialists
- MD/computer
- MD/communications/media uses
- MD/librarian, information specialist
- MD/legal

Services for Users, Consumers
- Clearinghouse services
- Advisory services
- Distribution
- "State-of-art awareness" (newsletter, abstracts publication)
- Acquisition, evaluation

Network Activities
- Network operations
- Network maintenance
- Network protocol; performance, including test, standards, regulation, monitoring and evaluation
- Network management, including measurements criteria, organizational and institutional characteristics, policy and procedural issues
- Network engineering, including configuration options, communication options, control options and media options
- User/Consumer responsiveness and interfaces
- Network interconnection (other groups, networks)

Experiment Design for Tests on Network

Experiment selection and planning: priorities setting

Test and evaluation standards

Evaluation procedures

Grants and other support mechanisms staff to provide for: extramural programs, fellowships, scholars-in-residence, visiting scholars (short term) and applied research on experiment needs.

As of FY 75, the Lister Hill National Center for Biomedical Communications has neither the manpower authorizations nor, for that matter, the physical space or technical facilities to provide for this skilled staff. Full manning must await the completion of the new building. Meanwhile, we are in the process of selecting a medical staff leadership, and senior scientists and engineers to head activities in three areas: Educational Technology, Computer Technology and Communications Technology.

Detailed program planning, especially for FY 76 and onwards, will increasingly reflect the interests and competences of these new managers, with FY 75 serving as a transition between the present ongoing programs of the Center and the new programs. The following trends seem reasonably predictable:

a. The Lister Hill Center's activities will be increasingly focused on service to the health educational community in general, and undergraduate and continuing medical and dental education in particular under the leadership of the Educational Technology Branch.

b. The Center will retain and expand its in-house competence in computer and communications technology, and will fully exercise its assigned mission as the DHEW focal point in communications technology.

c. Simultaneously, this technological competence is to be complemented by a new and equal competence in medicine, and in social and behavioral sciences. The new emphasis of the Center will be in adopting technology to meet the interpersonal and individual needs of the actual and potential users of that technology, be they faculty members, students or individual users of health care. Contract research to meet these needs is to be augmented by an increased intramural competence in these new health areas.

d. The National Library of Medicine has traditionally served as a repository of the printed record, in monographs and journals, of biomedical progress. A new emphasis on the application of information sciences should serve, not only to improve the Library's storage and retrieval of print and audiovisual materials, but also to examine the entire process of biomedical communication from creator to ultimate consumer. Traditional methods of publication and dissemination are slow, costly and inefficient. Information technology can be used to improve this process.

Specific programs of the three areas follow, to the degree of specificity that is possible at this time.

Educational Technology

The most salient public issue affecting the future of the health care professions involves the relative scarcity, maldistribution and high cost of health services. In question is the ability of the present system of medical education to respond to a pressing national requirement for the production of medical manpower. It is claimed that we are 50,000 physicians short; we need 250,000 nurses and 250,000 allied health personnel to give our citizens adequate health care. Health manpower is the foundation for providing care. Yet, despite the shortage, we find that the Nation's medical schools have room for only one third of all applicants; half of those who are not accepted are fully qualified. At the heart of the problem is the need to produce greater numbers of physicians and other health professionals oriented toward the practice of primary care medicine.

Two of the Center's proposed programs show great promise towards helping medical schools increase the number of students that they can educate without a corresponding increase in faculty and facilities.

Medical Simulation Training Laboratory A simulation is a verisimilar representative of real-world events or environments, incorporating the dimensions of time, from the perspective of the subject being trained. Simulations give the appearance of a truthful or realistic representation of a spatial-temporal chunk of the real-world to an individual or group of individuals experiencing the simulation. The instructional needs in medicine are of such complexity that simulation is likely to become the most important new educational development of the decade. (The Link Trainers

are perhaps the best known family of simulation devices.) The purpose of this initiative is to use simulation technology to streamline medical training programs in existing medical and allied health schools to produce greater numbers of better trained personnel in a shorter period of time.

Specifically, this new Medical Simulation Training Laboratory would provide support to accelerate and coordinate development of medical simulation research and development in general and, in particular by the development of specific instructional units and equipment exploiting simulation techniques and training methods.

FY 75 will mark the beginning of the necessary planning and feasibility studies, supplemented by an extramural research and development program to begin preparation for the installation of this laboratory in the Lister Hill Center building when it is ready for occupancy.

It is hoped that this laboratory will serve as a catalytic agent to facilitate interaction of the technological capabilities of the health industries on the one hand with the requirements of innovative medical educators on the other hand to accelerate development and incorporation of new and more cost-effective instructional techniques into the curriculum of health professions education.

Computer Assisted Instruction Since July of 1972 the Lister Hill National Center for Biomedical Communications has operated the LHNCBC Experimental Computer Assisted Instruction network for the interinstitutional sharing of CAI materials in biomedicine. The network has linked three university centers of CAI expertise with as many as eighty using institutions. The network's usefulness to the biomedical community is attested to by the increasing number of hours the network is used each month, and by the number of institutions who have showed willingness to at least partially share some of the communications costs.

The network in its present form is an effective, but not a cost-effective way of sharing CAI materials. Its present configuration is scheduled for termination in May 1975. Efforts during the coming years are to be devoted to testing alternative network configurations for distribution and local modification of CAI materials, to develop programs for faculty education about the appropriate uses of CAI, to gather, analyze and disseminate information about issues affecting content development, to test and participate in the development of methods for the evaluation of CAI materials, and to work towards greater user participation in financing, planning and eventually managing the CAI network.

Computer Assisted Instruction exists at the intersection of interests of the three Lister Hill Center branches. Educational technology is needed for the generation of programs, computer technology to implement them, and communications technology to carry the programs to their users.

Two of the many aspects of Computer Assisted Instruction are peculiarly appropriate for inclusion in the new building; a clearinghouse for biomedical CAI materials, and a faculty education/CAI material preparation laboratory.

Biomedical Computer Assisted Instruction Clearinghouse A CAI clearinghouse is more like a children's zoo than the traditional repository of dead materials—the teaching programs must be available to be examined and studied, and even taken home on occasion, rather than viewed as inert specimens. Computer Assisted Instruction programs must be placed on a computer to be screened, tested, evaluated. This single fact is the overwhelming consideration in such traditional clearinghouse functions as acquisition, cataloging, storage and dissemination.

Selection of materials for inclusion in the clearinghouse offers a particular challenge. There is no dearth of biomedical CAI programs; there is a dearth of evaluated and validated programs. Nor, as yet, is there any widely applicable method for validation of their effectiveness. If CAI is to compete effectively with other teaching technologies it must become a disciplined body of literature rather than the present anarchy. The Lister Hill National Center for Biomedical Communciations must work with individual institutions and other organizations to establish evaluation procedures. The creation and application of such evaluation procedures is a *sine qua non* for the successful functioning of the clearinghouse; it should have an ancillary effect on author incentives. The field at the moment lacks a precise equivalent to "publication in a refereed journal." If clearinghouse standards for acceptance are created and maintained at a sufficiently high level, acceptance of a CAI program by the clearinghouse may provide that equivalent.

Faculty Education/CAI Material Preparation Laboratory Computer assisted instruction materials were originally created by a few gifted individuals who combined subject expertise with a willingness to learn the details of computer languages and programming. As the field has grown we have seen increasingly fruitful collaboration between subject experts, computer specialists and experts in teaching strategies to devise methods for creating programs which do not require the subject expert to spend his scarce time in learning how to program a computer. The National Medical Audiovisual Center (NMAC) of the National Library of Medicine has had marked success with its laboratory for teaching faculty members how to prepare effective audiovisual teaching materials. Working with NMAC, we are planning a similar laboratory to teach faculty members how to prepare computer assisted instruction materials. Preliminary work will be done during the coming years, but the facilities made available by the new building will be necessary to bring this program to fruition. Both NMAC and the Lister Hill Center will be housed side by side in the new building.

Computer Technology

The biomedical community recognizes that computing, computer software and data communications technology has become an important new tool in the national health maintenance system. The proliferation of research, experiments and operational systems using these new tools has led to problems such as:

- Inefficient use of personnel and money resources because of duplication of efforts and limited computing, computer software and data communications expertise within the biomedical community;
- Proliferation of developments without "standardization" guidelines;
- No single place to get information about technical developments, research findings, medical resources, etc.;
- Lack of a recognized organization to provide leadership to initiate, guide and help with the use of computing, computer software and data communications technology.

A long term objective of the Lister Hill Center is to develop and maintain a strong research and development program in the computing, computer software and data communications technology necessary to meet the present and future needs of health related programs. This necessary research and development program:

a. Explores the state-of-the-art in the area of computing, computer software and data communications as it relates to the health education, maintenance and health services delivery system;

b. Provides the health maintenance and health services community a nationally recognized reference point for information about on-going research, findings, projects, and funding sources in computer software and data communications;

c. Promotes and develops technological standards;

d. Provides the health community with unbiased technical expertise and technical assistance on a consulting basis.

In fulfillment of its role in becoming a true focal point for the health community in the areas of computing, computer software and data communications, the Center intends to initiate and maintain a computerized, fully indexed inventory and bibliography of ongoing research, findings, projects and programs dealing with health-related computing, computer software and data communications technology, and to use the above data base as the basis for a recurring bibliography. As part of this program the Lister Hill Center will work with other health agencies to develop a program of joint sponsorship of regular recurring conferences dealing with health-related computing, computer software and data communications technology.

In direct support of the National Library of Medicine programs and services, the Center intends to develop alternatives for CAI material development and distribution, including:

a. Investigating the computer program architecture and program execution environment requirements for CAI interactions;

b. Investigating microprogramming techniques for information retrieval;

c. Investigating the use of intelligent terminal/cassette tape configurations;

d. Investigating the use of meta-compiler techniques as they would apply to the development and distribution of CAI materials.

On the basis of these results, the Lister Hill Center will develop alternative methods of distribution for CAI materials.

In another initiative the Lister Hill Center will investigate the use of large core minicomputers for initial file searching and input/output control for the National Library of Medicine's bibliographic retrieval services.

The Lister Hill Center intends to initiate the design and development of an integrated, operational computerized management information system to provide the National Library of Medicine management with data and timely analyses in the areas of administration, funding, budget performance, contract performance and costs of services.

The Center intends to work with the health community to develop and/or guide solutions to problems identified as lending themselves to solutions via computing, computer software and data communications technology. A small group of experts from the medical professional community, health-oriented foundations, health insurers, social sciences and other Government agencies will work together to recommend methods to be used in identifying health-oriented problems that lend themselves to solution via technology. The Center will implement the recommendations of the expert group and begin identifying problem areas, and develop applied research program plans to develop solutions to identified problems.

Facilities A computing laboratory will be needed to provide a "hands-on" experimentation testing environment with necessary hardware and test equipment. Initially, a medium-sized mini-computer and an "intelligent" terminal with a connecting slave terminal will be needed as the first hardware complement. This equipment will be used in the continuing investigation of microprogramming, meta-languages and pooling tape-to-tape communications methods.

Communications Technology

There are no basic technology constraints which could inhibit operation of a Biomedical Communications Network. There are a number of areas in which a substantial research and development program under the full or participating sponsorship of the Lister Hill Center could substantially advance technology and/or reduce costs and at the same time enhance the operational utility of the Biomedical Communications Network and other networks.

A key objective of the Lister Hill Center is to develop and maintain a strong research and development program in the communications technology necessary to meet the present and future needs of health-related programs. This necessary R&D program not only supports ongoing Lister Hill Center and National Library of Medicine services and experiments, but also explores the technological state-of-the-art boundaries to develop guidelines for future evolutions within the health community. The long range objectives of this program are to identify, evaluate and where appropriate, promote new applications for existing technologies in the area of biomedical communications, and to participate in the development of technological standards and guidelines.

The Lister Hill Center urgently needs, and the facilities afforded by the new building will make possible, an in-house capability to conduct research in communications technology.

An area of particular concern to the biomedical community is the most efficient use of communications channels. Narrowband image transmission can make it possible to transmit photographs of biomedical interest, such as x-rays, without needing the full capacity of a television channel. Audiovisuals—pictures with accompanying voice explanations—are already an important part of undergraduate medical education. They could be equally important in the continuing education of the practicing physician if methods can be developed to bring these materials to his desk when he needs them. Both cable television, in metropolitan areas and direct satellite to ground television offer challenging opportunities to develop this useful new technique.

As more and more privileged information—from physician-patient interviews to medical records—is transmitted over the Biomedical Communications Network there will be an increasing need to develop security systems, both for voice and for video, to protect the privacy and confidentiality of these transactions.

The National Aeronautics and Space Administration's communication satellites, ATS–1 and ATS–F have afforded the Center the opportunity to conduct useful experiments within a limited time frame. Our involvement with these satellites draws to a close, but we continue to have the need for a biomedical communication channel for low cost experimental usage. NASA's new Communication Technology Satellite (CTS) offers just that opportunity. This satellite, which will be launched in December

1975 is designed for experimental use in the low usage, high frequency 12 and 14 GHz bands. This satellite will be a joint venture between the United States and Canada, and will support experiments using direct broadband transmission between small ground terminals.

The Lister Hill Center plans to participate in this program both as an experimenter and as technical support agency for other health experiments, consolidating the technical programs of several experimenters and minimizing the unsought role of NASA as technical support group. The most significant reason for the Lister Hill Center's participation is the opportunity to develop an experimental broadband biomedical communications network with multistate coverage.

Detailed program plans for experiments with the satellite will be developed over the coming year. At the moment, the following organizations have expressed interest:

- WAMI—Washington, Alaska, Montana, and Idaho—continuation of experiments with the ATS–F satellite to foster the "medical school without walls" concept;
- Bureau of Health Resources Development (BHRD), Health Resources Administration (HRA)—disseminated undergraduate and continuing dental education;
- APACHE—Astral Program for Achievement of Continued Health—continuing health education;
- National Red Cross—First Aid Training;
- Lister Hill National Center for Biomedical Communications—National Medical Audiovisual Center—remote searching and delivery of audiovisual materials;
- Lister Hill National Center for Biomedical Communications—Stanford University—Connection of satellite terminal to Tymshare network for AVLINE searches and CAI experiments, especially for work with WAMI;
- National Library of Medicine—New York State Education Department—remote facsimile experiments in document delivery.

Facilities For the Lister Hill National Center for Biomedical Communications to effectively monitor satellite message traffic we need transmitters, receivers and antennas. The new building makes provision for the following facilities:

Satellite Terminal: From both electrical engineering and aesthetic considerations, the NIH campus is a particularly undesirable site for major satellite antennas. Plans have been developed to locate an earth terminal at the NIH Poolesville area. This facility as planned could support a 30-foot dish system with several smaller antenna systems.

Microwave Links: The roof of the Lister Hill Center building will have four microwave support structures. This will provide channels for communicating with the Poolesville facility and three additional terminal locations.

Transmit-Receive Facility: Located on the top floor of the Lister Hill Center building, beneath the roof antenna systems, will be the transmit-receive facility. Combined with the Poolesville terminal, these facilities should be capable of housing adequate communications systems to support several communications networks.

Network Control Center: The Network Control Center will function as the central technical control node for all Lister Hill Center Communications Networks. As such it will provide the equipment and facilities required for monitoring the status of network communications.

Communication Broadcast Room: The broadcast facility will support a limited television broadcast capability for the Lister Hill Center and the local health science community.

SUMMARY

Technology is a good servant, but a poor master. Technologists have been known to produce brilliant technological answers to questions that have not been asked. Conversely, however, those whose primary professional concern is with the training of health professionals, and with health care delivery have not always had easy access to competent, unbiased advice about possible technological solutions to some of their problems.

The purpose of the Lister Hill National Center for Biomedical Communications today, as it has been since its beginning, is to provide a forum where health care professionals with problems in biomedical communications, especially those problems amenable to possible solutions by the application of computer and communications technologies, can meet with those skilled in the applications of these technologies. The new medical leadership of the Center will strengthen its contacts with the medical community, and bring a new awareness of its problems, par-

ticularly those to which educational technology can contribute. A simultaneous reinforcement of the technical capabilities of the Center, aided and abetted by the increased laboratory and experimental facilities that the new building will make available, will enhance its ability to provide appropriate solutions to such problems.

The basic purpose of the biomedical communications networks the Lister Hill National Center for Biomedical Communications has developed and will develop in the future is to connect sources of medical knowledge with those who need that knowledge. There is an inevitable tendency for sources of medical knowledge to become more concentrated. There is an equal, and opposite tendency for the need for such knowledge to become more widespread. Whenever and wherever possible, within the limitations of the available technologies and the real needs of the various communities, the Center hopes to substitute the swift and certain transmission of electrical messages for the slow and expensive movement of people.

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